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Original Article

Household Long-Lasting Insecticide Nets (LLINs) Ownership, Use, and Perceptions among a Community Living in the Malaria Epidemic Zone of Nandi County, Kenya

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ABSTRACT

Background: Malaria remains a major public health challenge worldwide with most malaria illnesses and deaths being caused by *Plasmodium falciparum.* Mass distribution of long-lasting insecticide nets (LLINs) has been prioritised as a critical control measure for malaria in endemic countries. **Methods***:* A cross-sectional study was carried out to determine household LLINs ownership, use, and perceptions in a malaria epidemic zone of Nandi County, Kenya. A structured questionnaire was administered by trained interviewers to selected households in the area after obtaining consent from the household heads. **Results**: A total of 383 households were included in the study. Of the 383 households, 95% (95% CI: 92.9-97.2%) had at least one-bed net in use with each household having an average of 3-bed nets. Of these, 99.5% (95% CI: 98.1-99.7%) were hanged at the sleeping place. 79.5% (95% CI: 75.1-83.3%) of the hanged nets were in good condition (no holes), while 17.1% (95% CI: 13.3-20.9%) had holes. The majority of the LLINs were obtained from the mass net distribution either at home 31.7% (95% CI: 27.4-36.3%) or at the health facility 63.2% (95% CI: 58.5-67.8%). **Conclusion**: The study recorded a high level of household LLINs ownership and the use in the community, which points to the success of the free mass net distribution campaign in the area.

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INTRODUCTION

Despite major progress in the fight against malaria, the disease remains a major public health challenge in lower and middle-income countries [1]. Malaria is transmitted from one person to another through the bite of the female anopheles' mosquito, which harbours one of five species of parasites belonging to the genus Plasmodium [2]. With endemicity in more than 100 countries, almost half of the world population is at risk of malaria infection [3]. The heaviest burden of malaria is in the Sub-Saharan Africa region, with nineteen countries accounting for almost 85% of the global malaria burden by 2019 [4].

More than 75% of Kenya's population lives in areas where malaria is transmitted, making the disease a leading cause of morbidity and mortality [5]. According to the malaria indicator survey of 2015, at least 14,000 children are hospitalised annually for malaria, with an estimated 34,000 deaths among children under five each year. An estimated 6,000 pregnant women suffer from malaria-associated anaemia, and 4,000 babies are born with low birth weight as a result of malaria-induced maternal anaemia [5]. Economically, it is estimated that 170 million working days are lost each year because of malaria illness [5].

Kenya has four malaria epidemiological zones which include the endemic areas along the shores of Lake Victoria, where malaria transmission is perennial but peaks from June to August and again in late November; the highly populated epidemic-prone areas in the highlands including Nandi County, the study area; the epidemic-prone areas in the arid/semi-arid lowlands which are sparsely populated; and very low risk or transmission-free areas in the highlands above 2,000 meters. Malaria transmission in the epidemic-prone/seasonal areas is highest from May to July [5].

The Ministry of Health in Kenya considers investment in malaria control a priority for the realisation of the country's vision of 2030. In its current strategic plan, the programme aims to reduce malaria incidence and deaths by at least 75% by 2023. The programme has prioritised several interventions, among them the mass distribution of long-lasting insecticide nets (LLINs) [5].

Mass net distribution in Kenya started in the year 2002 with social marketing that promoted subsidised nets within the existing retail sector, but the coverage remained low [6]. This was expanded to heavily subsidised nets provided to children and pregnant women through the maternal and child health clinics in 2004 [6]. Following a substantial grant from Global Fund to Fight AIDS, Tuberculosis, and Malaria (GFATM), a campaign of mass distribution of free nets to all children younger than five years was organised in 2006 and 2011. Bed net ownership increased from 5.9% in 2003 to 50.2% in 2006 [6]. In the 2011 mass net distribution, the entire population at risk of malaria was targeted and was aimed at achieving universal coverage defined as one LLIN per two people in each household [7].

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Nandi County is one of the malaria epidemic-prone zones and was covered in the 2011 mass distribution of LLINs [7]. Studies have shown that ownership of an LLIN in the household is influenced by several factors including the socio-economic, presence of a pregnant woman or children under the age of 5 years, distance to the health facility, and net distribution strategy [8; 9; 10]. Furthermore, ownership of an LLIN does not translate into use [11]. The use of LLIN in a household has previously been shown to be affected by various factors, including sleeping arrangements in the house and availability of areas where nets can be hung [12], net bed ownership, age of bed net owner and their gender, marital status, the shape of the nets, heat discomfort as a result of using the net due to limited airflow, household size, occupation of the household head [13; 14].

Monitoring LLINs coverage in endemic malaria zones is central to evaluating the progress of malaria control under the Roll Back Malaria (RBM) partnership [15]. Furthermore, it helps to inform optimal programme implementation strategies within national malaria control programs [16]. Household possession of an LLIN, percentage of people with access to LLIN (2 persons for an LLIN), condition of the nets, and percentage of people reporting to have slept under LLIN the previous night are important indicators of net coverage as per the world health organisation (WHO) guidelines [17]. We carried out this study after two rounds of mass nets distribution in Nandi County to determine household LLIN ownership, use and the perceptions of the community.

MATERIALS AND METHODS

Study Area

The study was conducted in Nandi County (0°21'52" N and 0°16' 56" N in longitude and 35°5'20" E and 34°59'7" E in latitude). Nandi County lies on the Western side of the Rift valley and occupies 1,482 Km^2. It has five administrative divisions, including Kapsabet, Kilibwoni, Kosirai, Kabiyet and Kipkaren. The land rises from 1300-2500 m above sea level, an altitude defined as characterising the highland area and malaria epidemics and outbreaks had been reported within the sites previously. The topography of the study sites comprises hills, valleys, and plateaus. The area has a cool and moderately wet climate and receives mean rainfall of between 1,200-2,000 mm, with temperatures ranging from a mean annual minimum of 12 °C to a mean maximum of 23 °C. The study area has two rainy seasons, long rains season, from March to May, referred to as 'long rains' on account of the duration and high amount of rainfall received in many parts of the highland. The second season is the short rains from the months of October to December. The county had a population of 752,965 people as of 2009, with a mean density of 261 persons per Km^2. The average household size was 3.9, with a population growth rate of 2.9% per annum. However, population and settlement patterns are influenced by the topography and land potential. The life expectancy is 58 for males and 60 for females as compared to the National one of 66.5 years. [18]. Malaria prevalence has been reported to be moderate (13-25%) [19]. (10-34%) [20], peak incidences being reported during heavy rainfall seasons.

Study Population

The study population constituted 12 villages in the Kilibwoni and Kosirai divisions of Nandi County. The inclusion criteria for study participants were adult members (at least 18 years of age) in selected households in the study villages willing to consent to the study.

Study Design

This was a household-based cross-sectional survey conducted between the months of July and September 2014 with an aim to assess LLIN ownership, use, and community perceptions in 385 households in Nandi County. The definition of a household was any unit headed by a male or female with his/her dependents and/or spouse, who shared a cooking pot/common eating place and slept under the same roof [21].

Sample Size Calculation

The Fishers formula of 1999 was used to calculate the sample size. The study used a prevalence of 50% for LLIN coverage in highland epidemic areas [22], a level of significance and an error margin of 0.05, and a standard deviation of 95% CI (1.96) to

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calculate a minimum sample size of 385 households [23].

Sampling Procedure

Two divisions were randomly selected for the study. The multistage cluster sampling technique was used in selecting the study households. The two divisions (Kilibwoni and Kosirai) formed initial clusters. Kilibwoni and Kosirai divisions comprised 14 and 16 villages, respectively. Six villages were randomly selected from a list of all the villages from each cluster. Depending on the total number of households in each village, a minimum sample size for each cluster was allocated per village.

Data Collection Techniques

Data from the household was collected using structured questionnaires. Field workers (interviewers) who were fluent in both Swahili and the local dialect (Kalenjin) were selected from the community and trained on the study tools. The questionnaires were pre-tested, translated into Kalenjin and back-translated to identify ambiguities in translation. Written informed consent for study participation was obtained from all consenting household heads, after which a questionnaire was administered. The questionnaire collected data on demographic, household net ownership, the nature of the net (torn/not torn), number of persons who had slept under the net the previous night, number and ages of individuals in the house the previous night, but failed to sleep under a bed net the previous night, reasons why household members failed to sleep under a bed net the previous night, where the net was obtained and household economic activities. The presence and number of LLINs in a household were confirmed through observation.

Data Quality Assurance

Every evening, all the data forms (questionnaires) were submitted to the field supervisor, who checked that all questions had been answered correctly, and in case any question was left unanswered, a reason was given for quality assurance.

Data Analysis

The data collected was entered and stored in a spreadsheet. It was checked, and counter-checked for accuracy. Any discrepancy in the records was verified using the field questionnaires. The data was then cleaned and analysed using SPSS statistics 20.0 Statistical software for windows (SPSS Inc., Chicago, USA). The WHO indicators for LLIN universal coverage including LLIN household ownership, access, condition of the net within the household and people reporting to have slept under LLIN the previous, were used in the analysis [13]. These parameters were calculated and expressed in percentages. The 95% confidence intervals (95% CI) were calculated using binomial logistic regression.

Ethical Considerations

The study was reviewed and approved by the Ethical Review Committee of the Kenya Medical Research Institute (KEMRI) (KEMRI/SSC 2306). A written informed consent (Swahili translated) to participate in the study was obtained from all the participants. For illiterate individuals, a thumbprint was used to sign the assent and consent forms after a clear description of the study objectives and acceptance to participate.

RESULTS

Household Characteristics

Data were collected from a total of 383 households. Majority of the respondents 53.5% (95% confidence interval [CI], 48.4-58.6%) were from Kilibwoni area and of female gender at 74.9% (95%CI: 70.3-79.2%) (*Table 1*).

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Table 1: Household characteristics

Characteristics		Frequency (n=383)	Percentage	(95%CI)
Sex	Male	96	25.1	20.8-29.7
	Female	287	74.9	70.3-79.2
Age	18-25	114	29.8	25.2-34.6
	26-35	120	31.3	26.7-36.2
	36-45	108	28.2	23.8-33.0
	>45	41	10.7	7.8-14.3
Level of education	Primary	215	56.1	51.0-61.2
	Secondary	100	26.1	21.8-30.8
	Tertiary	50	13.1	9.9-16.9
	No formal education	18	4.7	2.8-7.3
Occupation	Farmer	257	67.1	62.2-71.8
	Business person	53	13.8	10.5-17.7
	Employed	30	7.8	5.4-10.9
	Housewife	43	11.3	8.3-14.8
Division	Kosirai	178	46.5	41.4-51.6
	Kilibwoni	205	53.5	48.4-58.6

LLIN Access and Coverage

The majority of the households, 95% (95% CI: 92.9 - 97.2%), had at least one LLIN at the time of the study. The number of LLINs per household ranged from one to nine and on average, each household possessed three LLINs (standard deviation=1) (Table 2).

Physical Condition of the LLINs

A total of 377 LLINs were observed in their physical condition. The majority of LLINs, 79.2% (95% CI: 75.1-83.3%) were found to be in good condition (no holes). Another 17.1% (95% CI: 13.3-20.9%) had holes. Two LLINs (0.5%) were not in use and had not been unwrapped from distribution packs. The respondents reported that they had more LLINs than their sleeping places. It was also noted that the households where these two nets were found had more than four nets. In most of the nets surveyed, 99.5% (95% CI: 98.1-99.7%) were found hanging over the sleeping places (*Table 2*).

Table 2: Household LLINs coverage and condition

Characteristics		Number (Observed)	%	(95% CI)
Presence of bed net (n=383)	Yes	364	95.0	92.4-97.0
	No	19	5.0	3.0-7.7
No. of nets (n=364)	One	36	9.9	7.1-13.4
	Two	121	33.2	28.4-38.3
	Three	108	29.8	25.0-34.7
	Four	66	18.1	14.3-22.5
	>4	30	8.2	5.6-11.6
	No response	3	0.8	0.2-2.4
Condition of all nets (n=377)	Hanged at sleeping place	375	99.5	98.1-99.7
	Not hanged at sleeping place	2	0.5	0.1-1.9
Condition of the hanged nets (n=375)	In good condition (no holes)	297	79.2	75.1-83.3
	With holes	64	17.1	13.3-20.9
	Torn apart	8	2.1	0.7-3.6
	Seriously worn out	6	1.6	0.3-2.9

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Household LLIN use

Most of the respondents 91.4% (95% CI: 87.2-93.4%) reported that they had slept under LLINs the night preceding the survey. Those who had not slept under LLINs gave various reasons including being away the previous night and not being accustomed to routinely sleeping under the net. The majority of the LLINs underuse in the study area had been acquired at no cost during the net distribution either at their homes 31.7% (95% CI: 27.4-36.3%) or at the health facilities 63.2% (95% CI: 58.5-67.8%).

The median (interquartile) duration of LLINs use was 2 (1 to 4) years. Overall, 110 of the 364 respondents (30.2%) said their LLINs had been in use for one year, while 26.9%, 12.3% and 8.0% of the respondents stated that they had used the net for two, three and four years, respectively. Others reported having used their nets for five years (12.6%) with a minority reporting usage for more than five years (9.0%) (*Table 3*).

Table 3: Household LLIN use

Characteristics		f	%	(95% CI)
Slept under a net the night prior to the survey (n=364)	Yes	330	90.7	87.2-93.4
	No	34	9.3	6.6-12.8
Reasons for not sleeping under a net (n=34)	I was away	5	12.9	3.6-29.8
	Usually, I do not use the net	23	71.0	51.9-85.8
	No response	6	16.1	5.5-33.7
Source (n=438)	Given during a free net distribution at home	139	31.7	27.4-36.3
	Given for free at the health facility	277	63.2	58.5-67.8
	Bought from a health facility	7	1.6	0.6-3.3
	Bought from a shop/ supermarket.	15	3.4	1.9-5.6
Duration/use of the net (n=364)	1	110	30.5	25.5-35.2
	2	98	27.1	22.4-31.8
	3	45	12.5	9.2-16.2
	4	29	8.0	5.4-11.3
	5	46	12.7	9.4-16.5
	>5	33	9.1	6.3-12.5
	Do not know	3	0.8	0.2-0.3

Community Perceptions about LLINs

Asked whether it was important to sleep under LLINs, many of the study participants responded with a positive 97.7% (95% CI: 95.5-98.9%). Of those who responded that it was important to sleep under LLINs, 92.0% (95% CI 88.8-94.7%) reported that protection from mosquito bites was the biggest benefit, with another 5% (95% CI 3.5-8.5) mentioning prevention from malaria as a benefit accrued from sleeping under the LLINs. Of the five respondents who were of the opinion that sleeping under LLINs was of no importance, two complained that using a mosquito net every day had proved to be a nuisance, while two declined to reply to this question (*Table 4*).

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Table 4: Community perceptions about LLINs

Characteristics		f	%	(95% CI)
It is important to sleep under a mosquito net (n=383)	Yes	374	97.7	95.6-98.9
	No	5	1.3	0.4-0.3
Reasons for using net (n of 374)	No response	4	1	0.3-0.3
	Protection from mosquito bites	344	92	88.8-94.7
	Prevents me from getting malaria	21	5	3.5-8.5
	Helps me sleep well	9	3	1.1-4.5
Reasons for not using the net (n=5)	It is a nuisance to use the net every day?	2	40	5.3-85.4
	No response	3	60	14.7-94.7

DISCUSSION

This study assessed LLINs ownership, use, and perceptions at the household level in the malaria epidemic zone of Nandi County. WHO indicators include the percentage of households possessing at least one LLIN. Condition of LLIN and percentage of people reporting to have slept under the net the previous night [17] were used. In this study, a high percentage of LLINs ownership at the household level was reported, with 95% of the households having at least one LLIN at the time of the survey. This was a steady increase from the 71% reported in 2009 in western Kenya [13], 59.5% ownership reported during the 2010 Malaria indicator survey [22], and 84.4% reported by Zhou et al. during the 2010-2013 study in the same area [7]. The high LLINs ownership is similar to previous studies in western Kenya [22], Nigeria [25], and Bhutan [26]. Recent studies in other countries have recorded low LLINs ownership even after free net distribution like in Ethiopia [27; 28]. The high LLIN ownership can be attributed to the concerted efforts by the Ministry of Health to increase LLIN ownership from 5.9% in 2003, 50.2% in 2006 [6;29], to the current 95% in the study area through mass net distributions in 2006, 2011 and 2012.

The number of LLINs per household ranged from one to nine and on average, each household possessed three LLINs (standard deviation=1). These results therefore show that the Government's efforts toward the free mass distribution of LLIN have substantially increased household ownership of nets. Similar findings have been reported [7]. Mass distribution campaigns have been found to be a cost-effective way to rapidly achieve high and equitable LLINs coverage in at-risk populations [30].

Although previous studies in other countries have indicated variations between net possession and use, for example, Ethiopia [31], Sudan [32], Nigeria [25], and Tanzania [33], this study reported a high percentage of net use in the night prior to the survey at (91.4%). A look at the community perceptions about LLINs use shows that a majority of the respondents deemed it important to sleep under LLINs, for protection from mosquito bites and to prevent themselves from getting malaria. Other studies in Kenya have also recorded high net usage [12;34].

Study participants who had not slept under LLINs gave various reasons for not sleeping under a net, including being away the previous night and not being accustomed to routinely sleeping under the LLINs. This showed that some people in the community were yet to appreciate the importance of sleeping under LLINs. This calls for continuous bed net use campaigns, probably through the community outreach programs and the use of Community Health Volunteers (CHVs).

The study team made observations on the condition of 377 LLINs in the households and found out that 99.5% of them were hanged over their sleeping places. The study did not find out whether hanging the bed net over the sleeping places could have any influence on the use of the bed net. However, other studies have linked the use of LLINs to human factors like the hanging of the bed net and the age of the user [35].

The median (interquartile) duration of LLINs use was 2 (1 to 4) years in the study, but still, some of

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the nets had been in use for more than five years. The study also found that 21% of the 377-bed nets had holes. Although experimental studies have reported that purposely perforated LLINs can still kill mosquitoes and prevent mosquito bites, the formation of holes is concurrent with insecticide loss. It is, therefore important to take into account both aspects in determining the useful life of the nets [36].

Some nets were also found still unpacked from the distribution packs in some households. Similar results have been documented in Ethiopia, where some LLINs had never been used [37]. A study in Cameroon attributed the scenario where nets were still in the package to ignorance on the part of the population [38]. However, in our study, the households where LLINs were still in the distribution packs possessed more than four LLINs at the time of the survey, and thus the nets were surpluses.

The national malaria control program (NMCP) has used different LLINs distribution channels including health facilities to reach the most at-risk population, community health volunteers, and commercial outlets. In the study area, a majority of the nets had been acquired at no cost, either from the health facilities or through free mass net distribution.

CONCLUSION

The study shows a high level of household LLINs ownership and uses in the community, which points to the success of the free mass net distribution in the country. However, there were pockets among the study participants who did not find it important to use the LLINs.

Recommendations

The study recommends continued community campaigns and education on the importance of LLINs use.

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